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Modelling Efficacy of Average Age on Capital Investment Returns: A Case of Kenya between 1965 and 2015

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ABSTRACT

Demographic changes have long been assumed to affect investment decisions. Little is known about the effectiveness of average age on capital investment. This study, therefore, sort to establish the efficacy of average age on capital investment as a percentage of GDP. The study used secondary data sources from the public website. Data analysis via SPSS utilized Pearson's correlation analysis, Analysis of Variance, and regression analysis. Pearson's correlation values is obtained as -0.294. ANOVA test revealed that F statistics was 9.735 and is higher than F critical, suggesting that average age is statistically significant in predicting capital investment. Regression analysis indicated that coefficient value is -15.074. The study concludes that average age negatively influence capital investment and is useful in predicting capital investment in Kenya. The study recommends an extension of the period under review and the addition of other demographic variables to add knowledge to the area.

KEYWORDS: *Average Age Increase, Capital Investment*

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1. INTRODUCTION

Investment is defined as the allocation of monetary resources to asset with the aim of future gains [1]. There are many investment avenues available for an investor. In this study, the focus is on capital investment, which are monetary resources allocated to a company or firm to enable its financial objectives [2].

Age is pivotal in risk perception related to investment decision making [3]. For instance, age is identified to have a significant effect on investors' level of confidence in investment decisions [4]. [4] asserts that young investors are risk-averse than their aging counterparts and hence tend to seek for more investment opportunities.

Age exhibits investors' risk perception and sound financial knowledge [5]. The peak financial decision-making age is 53, while financial decisions increase between 20 to 30 years old and level off from 70 to 80 [5]. [6] and [7] argued that demographic variables (age, gender, education, and occupation) are an essential factor in determining financial decision making for investors. The existing studies have not shown a mathematical relationship between average age increase on capital investment. Thus additional knowledge on the subject will help financial institutions and individuals make adept decisions.

Several studies have attempted to link demographic factors to influence the level of investment behaviors. Investor's age has been established to have effect on investment decisions and preference [8, 9, 10]. A more recent study has suggested that individuals tend to make better investment decisions as they grow older [11]. Forecasters suggest the demographic growth of Africa will double by 2036, and such has presented geo-economic and political concern to all stakeholders [12]. The solution to many raising concerns among them, high unemployment rate, has lately shifted reliance on investment opportunities to accommodate this high population [13, 12]. Economist has strongly stressed more capital investment to provide enough employment for the projected population growth [14, 15]. Economists

focus on current capital investment as a key to solving problems associated with population growth has been theorized and thus lacks a robust research background: these opens-up opportunities to investigate their claims from a scientific perspective.

As stated in the preceding paragraphs, not much is known about the influence of average age on capital investment since the existing studies suggest a linkage between this variable and the holistic approach of investment decisions. Therefore, the research focuses on modeling the efficacy of average age increase on capital investment in Kenya between 1965 and 2015.

Contribution

The proposed study has two major contribution

1. We provide direct and indirect mathematical relationship behind average age increase on capital investment.
2. The results adds literature on how mathematical models can be used to show the relationship between average age on capital investment.

The rest of the paper is organized as follows: Section 2 presents literature review showing relationship between average age increase and capital investment. Section 3 presents methodology used to achieve the study objective. Section 4 presents the results and discussion. Section 5 provides a summary of the study findings and future work.

2. Literature Review

2.1. Theoretical Review

Higher average age occurs when there is a rise in longevity and a drop in fertility [16]. This affects savings as longer life stresses the economic system since the old consume more than they earn throughout their earnings. Therefore, a population characterized by older people have less investment, and consequently, less investment return is received. On the other hand, countries with a longer lifespan with little support for older people see substantial investment among the youthful age groups [17]. Many economic and mathematical models suggest a linkage between demographic changes and capital or asset investment returns [18, 19, 20]. The main challenge has been to show the linkage between the aging population in the developing countries and capital investment return. Poterba [16] developed a simple overlapping-generation model that shows the basics understanding of demographic changes on investment return. Poterba *et al.* [16] model assumes individual work when; young (ψ) and old (α). If we normalize the production while working on a unit price of a good, and assuming the presence of a durable capital (whose values does not depreciate and is fixed in supply), and saving rate out of labour income for the young is fixed at ξ then asset demand when the total number of young workers Λ_ψ is given by $\Lambda_\psi * \xi$. If we fix the supply of durable asset $\mathcal{K}$, then the relative prices of these assets in terms of the unit price of good ρ must be such that [16],

$$\rho\mathcal{K} = \Lambda_\psi \xi. \qquad (1)$$

Equation (1) suggests that an increase in the young population increases the size of young workers, which drives the asset prices to counteract the higher demand for financial asset holding and fixed physical supply of capital. This will have a greater impact on the return on investment since the ψ population will purchase assets at high prices. Equation (1) suggests that a smaller number of young population in the economy will yield low asset prices, hence increasing return on investment.

The model described by Equation (1) neglects important asset pricing and return but still make it ideal for investment. The key assumptions include [16]: fixed saving rate for young workers; fixed supply of capital; close economy, that is, where there are no international capital flows; and other economic effects of population aging. A more sophisticated model would neglect a fixed saving rate for young workers and vary saving rates in expectation of future fluctuations of return. This would require an optimization model to simulate household behavior in terms of expenses that will affect savings. This would affect the prices of financial assets among the young population ψ, hence affecting investment return. This assumption suggests that if the saving rate of workers in aged population cohort (higher average age) is lower than that for younger workers (lower average age), then the demand for capital will be lower and model presented by Equation (1) will be inefficient in suggesting the asset investment return [16].

When the supply of capital is fixed, the impact of shocks on asset demand is amplified and will affect the growth of capital stock [21]. Abel [22], Bakshi and Chen [20], Davis [21], Lim and Weil [23] shown that allowing supply curve of capital goods links demography to asset prices. [20] also suggested that allowing variation of capital stock without any adjustment cost will allow capital to be priced at its production cost. When this happens, then demographic changes will not affect the price of financial assets. However, the reality posits that cost adjustment is inevitable, and thus capital stock will always suggest a linkage between demography and asset prices and returns [21, 23].

Assuming a closed economy without international capital flows suggests the supply of capital must be equivalent to contemporaneous demand for that capital [16]. Variation in the price of capital is more when there are no international capital flows and hence permit the elastic supply of capital. In reality, this scenario is not possible since globalization has allowed for full integration of capital markets, asset prices, and rates of return [23]. Therefore, global demographic forces always affect capital markets, asset prices, and rates of return to the extent that affect the supply savings. Capital flows across a border make this assumption untenable. However, perfect capital market integration seems inconsistent with empirical evidence.

The model presented by Equation (1) does not consider the effect of changing age structure on non-financial aspects of the economy like the rate of productivity growth (playing a significant role in determining asset values and rate of return). Cutler *et. al.* [24] suggests that there exists a linkage between age structure and rate of productivity improvement, then other factors linking demographic changes to equilibrium factor returns would have little effect.

2.2. Empirical Review

Empirical evidence have show a strong correlation between country's investment rate of return and saving rate ([21, 16] suggest that average age dynamics is linked to saving rate). [25, 26, 27] present a link between capital market and domestic population structure and demand for financial assets.

Other models have explored the effect of population aging (average age increase) on asset markets in stylized models that try to incorporate a more realistic description of saving behavior and asset price determination, which also describes asset return [22]. The models overlap generations where the population is assumed to live for long years and formulate rational life-cycle plans. [28] presented results based on overlapping generation model with fluctuated supply capital. The model relatively assumes the rise and fall of average age, which leads to a reduced rate of return, contrary to a steady-state economy with a relatively stable average age.

Brooks [29], Geanakoplos [30], Poterba [31], and Yoo *et al.*[32] presented models that suggest that demographic changes affects capital market returns. Although the findings are similar across all these models, the magnitude of varies. For instance, Brooks (2002) model assume individuals lives depend in: childhood; young working age; older working age; and retirement. Childhood is characterized by dependence on the young workers. Workers supply inelastic labor and receive after-tax wage. Workers consume a fraction of their after-tax wage and invest the rest based on portfolio decision over risky capital and safe bonds. Retirees only consume their savings. In developed system (countries), retirees are paid Defined-Benefit (DB) or retirement benefit indexed to current wages at a replacement rate β. More specifically, young worker in time t maximizes expected life time utility in Equation (2) to budget constraints in young working age Equation (3), old working age Equation (4) and retirement Equation (5) [29]:

$$\Omega_t = \upsilon(1-\chi_t)\frac{(\mu_t^0)^{1-\pi}}{1-\pi} + \frac{(\mu_t^1)^{1-\pi}}{1-\pi} + \omega\delta_t\left[\frac{(\mu_{t+1}^2)^{1-\pi}}{1-\pi}\right] + \omega^2\delta_t\left[\frac{(\mu_{t+2}^3)^{1-\pi}}{1-\pi}\right] \tag{2}$$

$$(1+\chi_t)\mu_t^0 + \mu_t^1 + \xi_{\varepsilon,t}^1 + \xi_{\beta,t}^1 = \theta_t(1-\zeta_t) \tag{3}$$

$$\mu_{t+1}^2 + \xi_{\varepsilon,t+1}^2 + \xi_{\beta,t+1}^2 = \theta_{t+1}(1-\zeta_{t+1}) + (1+\epsilon_{\varepsilon,t+1})\xi_{\varepsilon,t}^1 + (1+\epsilon_{f,t})\xi_{\beta,t}^1 \tag{4}$$

$$\mu_{t+2}^3 = (1+\epsilon_{\varepsilon,t+2})\xi_{\varepsilon,t+1}^1 + (1+\epsilon_{f,t+1})\xi_{\beta,t+1}^1 + \beta\theta_{t+2} \tag{5}$$

where μ_t^0 is the young workers' children's consumption with discounted factor υ; ω reflects young workers' subjective rate of time preference, π is young workers coefficient of relative risk aversion. Young workers choose consumption μ_t^1 and their children $(1+\chi_t)\mu_t^0$ where χ_t is cohort growth. Young workers make portfolio decision over risky capital $\xi_{\varepsilon,t}^1$ and safe bonds $(\xi_{\beta,t}^1)$ and $(t+1)$ is bond return period t and denoted by $\epsilon_{f,r}$. The return on capital is not realized until period $(t+1)$ and is denoted by $\epsilon_{\varepsilon,t+1}$. The output of the model represented by Equation (2)-(5) is generated by the Cobb-Douglas production function, where capital and labour are the main output. A stochastic total factor of productivity (TFP) makes returns on capital for young and workers risky. The total age distribution in time t consist of Λ_{t-1} young workers, Λ_{t-2} old workers and Λ_{t-3} retirees. The time t for child cohort is defined by $\Lambda_t = (1-\chi_t)\Lambda_{t-1}$ and the cohort growth is stochastic, β is the exogenous replacement rate and payroll taxes balances pay-as-you-go pension system and rising with the retiree to worker ratio: $\zeta_t = \beta\frac{\Lambda_{t-3}}{\Lambda_{t-1}+\Lambda_{t-2}}$. Brooks [29] models were calibrated so that each period t represented 20 years. Brooks [29] models were only suitable for developed countries and, therefore, inappropriate for developing countries like Kenya, where many of the model parameters are unrealistic and untenable. Besides, the proposed study focuses on modeling the average age increase on capital

investment return, which makes [16] model more useful due to its simplicity and realistic in terms of modeling parameters available.

3. Methodology

3.1. Data Source

The study utilized time-series secondary data for demographic variables, and capital investment return for Kenya collected between 1965 and 2015. The secondary data sources are sourced from

https://www.worldometers.info/world-population/kenya-population/ while capital investment was sourced from https://www.theglobaleconomy.com/Kenya/Capital_investment/

3.2. Model

The model for average age increase and capital investment return is borrowed from the works of [16] as presented in Equation 1, that is,

$$\rho\mathcal{K} = \Lambda_{\psi}\xi.$$

where ρ is the relative unit prices of durable assets, $\mathcal{K}$ is fixed supply of durable asset, Λ_{ψ} is the total number of young workers, ξ is a fixed saving rate out of labor income for the young population, and $\Lambda_{\psi}\xi$ is the asset demand. If we assume a unit fixed saving rate and $\bar{\Lambda}_{\psi}$ average age increase, and ρ is endogenous to return on investment, thus return on capital investment ρ_{RCI} will be given by

$$\rho_{RCI} = \frac{\bar{\Lambda}_{\psi}\bar{\xi}}{\bar{\mathcal{K}}}, \qquad (6)$$

where $\bar{\mathcal{K}}$ is the average fixed supply of assets and $\bar{\xi}$ average labor income corresponding to average age increase.

4. Results Analysis and Discussion

4.1. Data

The models are evaluated using R-Programming. Data analysis also employs The Statistical Package for Social Science (SPSS) to obtain a correlation analysis to get the causal relationship between independent and dependent variables. Analysis of Variance (ANOVA) is employed to perform model fit and establish the efficacy demographic variable changes on capital investment. Regression analysis is done to establish the linear relationship between the dependent variable and independent variables to support the findings from model analysis from Equation (6).

The study modeled the efficacy of demographic variable changes on capital investment returns in Kenya between 1965 and 2015. Thus, data are collected for independent variable average age increase and dependent variables (Capital investment). Table 1 5 year interval data collected between 1965 to 2015 and source.

Table 1: Demographic variables and capital investment data collected for the period between 1965 and 2015

Year	Average Age Increase (%)	CI ((%) of GDP)
1965	-7.69	14.39
1970	-2.46	24.4
1975	-1.92	18.14
1980	-1.10	24.51
1985	-0.01	25.32
1990	2.9	24.16
1995	.386	21.82
2000	3.74	17.41
2005	3.35	17.65
2010	2.94	20.84
2015	4.4	21.47

Source: Researcher

4.2. Analysis

4.2.1. General Statistical Analysis

Graphical representation of data

The general graphical trends of data collected are presented in Figures 1 and 2.

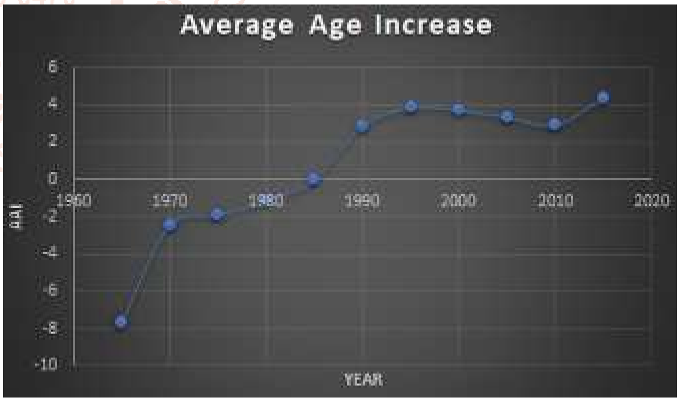

Figure 1: Summary of average age increase trend from 1965 to 2015.

Figure 1 shows a sharp average age increase between 1965 and 1970. There was almost no change between 1970 and 1975. The average age increase gradually rises between 1950 and 1995. It then followed by a decline between 1995 and 2010, before a sharp rise to 2015. However, in general, the average age increase was between 1965 and 1985 while positive from 1985 to 2015.

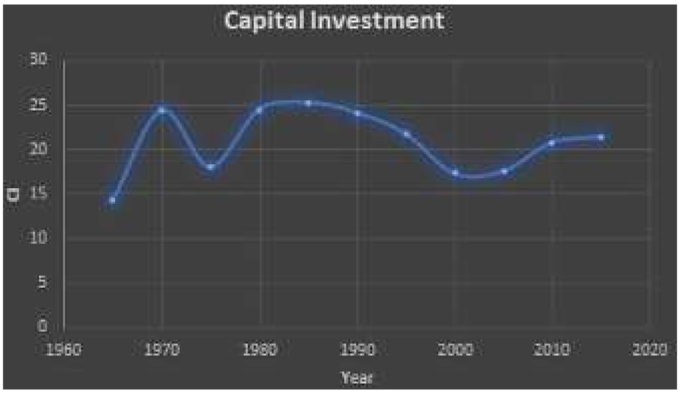

Figure 2: Summary of capital investment trend from 1965 to 2015.

Figure 2 shows a sharp increase in capital investment between 1965 and 1970. It then followed by a sharp decline between 1970 and 1975 before a rapid rise to 1980 before a gradual decline to 2000. A gradual rise is seen between from 2000 to 2010 and a slight increase between 2010 and 2015.

Descriptive Statistics

The study also sorts to explore the descriptive statistics of data collected. The descriptive statistics results are presented in Table 2 reveal that average age increase between 1965 and 2015 and capital investment is 20.9191% of GDP. Standard deviation is a measure of the closeness of values to the mean. Thus, low standard deviation shows indicate less spread values. Standard deviation less than unit indicates closely fit data. Table 2 indicate that average age increase has standard deviation of 3.752, which indicate it has wider spread and variation.

Table 2: Descriptive statistics of demographic variables and investment data collected for the period between 1965 and2015

Variable	Mean	Std. Deviation
Average Age Increase	0.7282	3.75200
Capital Investment	20.9191	3.59663

Source: Researcher

4.2.2. Correlation Analysis

The study employs Pearson's correlation analysis to find the strength and direction of the linear relationship between dependent and independent variables. The higher the values, the stronger the relationship. The relationship can either be $+ve$ or $-ve$, and the values range from -1 to 1. However, the closer the values are to either -1 or 1 shows, the stronger the relationship. Significance level shows the statistical significance relationship between the independent variable: average age increase and dependent variables capital investment.

Table 3: Pearson's correlation values between independent variable: average age and dependent variable: capital investment

Item	Capital Investment	Significance
Average Age Increase	0.252	0.455

Source: Researcher

Table 3 indicate that only average age has a negative correlation with capital investment.

4.2.3. Regression Analysis

Regression analysis presents model summary, ANOVA and regression coefficients.

4.2.4. Model Summary

Model Summary for the modeling efficacy of demographic changes on and capital investment.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.832a	.693	.488	2.57398	.693	3.381	4	6	.089

a Predictors: (Constant), AAI.

The model summary results give the strength of the relationship between the dependent variables and the model. R, which is equal to $.832$, is the multiple correlation coefficient. R shows the linear correlation between the observed and model-predicted values of the capital investment as the dependent variable. $0 \leq R \leq 1$ and large values are preferred since they indicate a strong relationship. R Square, which is equal to 0.693, is the coefficient of determination. It shows the variation of the model parameters. Adjusted R Square is a modified R Square statistic based on large parameters in the model. Change statistics are essential in the selection of the model. However, in this case, we only have one model; hence there use is insignificant.

4.2.5. ANOVA

The resulting ANOVA output is,

ANOVAa

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	89.605	4	22.401	3.381	.089
	Residual	39.752	6	6.625		
	Total	129.357	10			

a Dependent Variable: CI

b Predictors: (Constant), AAI.

The results above show the F value is 3.381 and using F-distribution table at $\alpha = 0.05$, $F_{0.05;4,6} = 4.5337$. Since the F critical is more than F statistics, hence the average age is significant in modeling capital investment output. The p-value for 3.381 is 0.089 and since $\alpha = 0.05 < 0.089$, implying that the test statistic is not significant at that level.

4.2.6. Regression Coefficients

The regression analysis coefficients are summarized as,

Coefficients for regression analysis

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-55.757	46.596		-1.197	.277
	AAI	1.101	.666	1.148	1.652	.150

a Dependent Variable: CI

Output above suggest that regression model equation of the form $Y = \beta + \beta_1 x_1$ where Y is Capital Investment (CI), $\beta_i : i = 1$ are constants coefficient of regression analysis, $x_j : j = 1$ are independent variables, i.e., AAI. Based on the output, regression equation can be constructed as,

$$Y = -55.757 + 1.101x_1 - 8.078x_2 + 0.623x_3 + 0.673x_4. \quad (7)$$

Equation (7)) suggests that average age increases capital investment while population growth rate decreases capital investment. The output also suggested that all the average age is statistically insignificant predictor since coefficient $p - values = (.150.625) < 0.05$.

4.3. The Model

We use analogy in Section 4.2.3 to satisfy the study objectives.

The model for average age increase and capital investment return is presented in Equation 6 as borrowed from the works of [16] as,

$$\rho_{RCI} = \frac{\bar{\Lambda}_\psi \xi}{\mathfrak{R}}. \quad (8)$$

where ρ_{RCI} is the return on capital investment, $\bar{\Lambda}_\psi$ average age increase, ξ is the average saving rate of Kenya population and $\mathfrak{R}$ is the average fixed supply of assets. Regression analysis test of capital investment and average age increasing assuming population growth rate, life expectancy and dependency ratio are constants is presented below. Thus, Equation (8) can be written as,

$$\rho_{RCI} = 0.241\bar{\Lambda}_\psi. \quad (9)$$

suggesting that $\frac{\xi}{\mathfrak{R}} = 0.241$.

Coefficients for regression analysis

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	20.743	1.129		18.374	.000
	AAI	.241	.309	.252	.781	.455

a Dependent Variable: CI

4.4. Discussion

Age is pivotal in investment decision making and affects the level of confidence of investors. Therefore, it is expected that as average age increases, so is the capital investment returns (see Figures 1 and 2). [5, 7] have also supported this observation and noted that financial decision making increases with age. Looking closely at the Figures 1 and 2 capital investment return increases as age increases. Further analysis shows that between 1965 and 1970, the average age increases rapidly, so is capital investment.

Correlation analysis shows that the average age increase has a positive correlation with capital investment return. Although the relationship is not statistically significant, the strength of the relationship is significant. This observation is supported by existing studies that have shown that there is a strong positive relationship between average age increase and capital investment return [16, 5, 6, 7].

Regression analysis gives $R = 0.832$, which indicates a strong linear correlation between average age increase and capital investment return. The coefficients of the regression analysis show a positive relationship. If other demographic values are assumed constant, the average age increase indicated a stronger and positive linear relationship with capital investment return. It is also worth noting that if only average age increase is assumed to influence capital investment return, then the coefficient of regression analysis is positive and statistically significant. All these observations are summarized in Equation (9), estimating a mathematical model explaining the relationship between average age increase and capital investment. The estimated equation also suggests that capital investment return would increase as average age increases.

5. Conclusion

The study established the effectiveness of demographic changes in capital investment in Kenya. The study specifically sort to estimate mathematical model explaining the relationship between average age increase and capital investment in Kenya. Through analysis of secondary data, average age increase was obtained to have positive correlation with capital investment. Regression analysis indicated average age positively affects capital investment returns. The findings of the study established that Equation (9) can be used to explain the mathematical relationship between average age increase, and capital investment. Future work on the topic needs to expand the study to other countries in order to have a more comprehensive understanding of the relationship. Further analysis should also be adjusted to accommodate all demographic variables.

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